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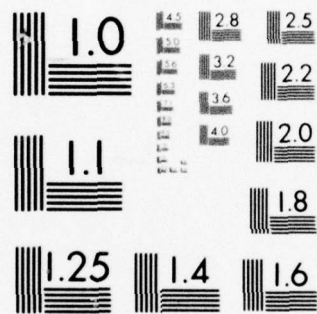


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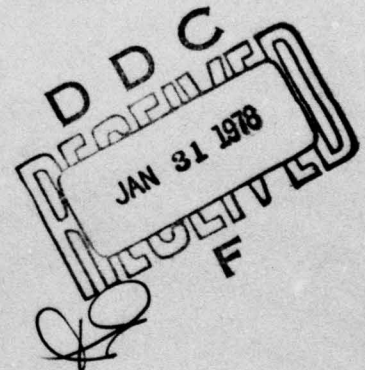
**DESTROYER ENGINEERED OPERATING CYCLE
(DDEOC)**

**System Maintenance Analysis
FF-1052 CLASS
FUEL OIL SERVICE AND TRANSFER SYSTEM
SMA 112-260**

REVIEW OF EXPERIENCE

July 1977

**Prepared for
Director, Escort and Cruiser
Ship Logistic Division
Naval Sea Systems Command
Washington, D. C.
under Contract N00024-76-C-4319**



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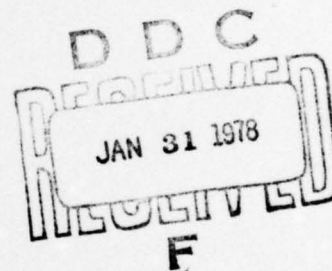
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FOREWORD

This report, the Review of Experience, documents the historical maintenance experience for the FF-1052 Class Fuel Oil Service and Transfer System, presents an analysis of the problems encountered, and recommends actions to improve system material condition. It has been developed for NAVSEA 934X, the sponsor of the Destroyer Engineered Operating Cycle (DDEOC) Program, under Navy Contract N00024-76-C-4319.

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SUMMARY

The goal of the Destroyer Engineered Operating Cycle (DDEOC) Program is to effect an early improvement in the material condition of ships, at an acceptable cost, while maintaining or increasing their operational availability during an extended operating cycle. In support of this goal, System Maintenance Analyses (SMAs) are being conducted for selected systems and subsystems of designated surface combatants. The principal element of an SMA is the Review of Experience (ROE). This report documents the ROE for the FF-1052 Class Fuel Oil Service and Transfer System.

An ROE is an analysis of existing and anticipated problems that affect the operational performance or maintenance program of a ship system. The ROE report serves as a vehicle for assessment of the significance and consequences of identified problems. It also presents specific recommendations and a system maintenance policy for preventing or reducing the impact of problem occurrence, while improving material condition and maintaining or increasing system availability throughout an extended operating cycle.

The fuel systems of all FF-1052 Class ships have received the Navy Distillate (ND) conversion package; the analysis described in this report was limited to the components as they existed following the conversion.

All available maintenance data were analyzed in the Fuel Oil Service and Transfer System ROE. The documented maintenance experience of the system was reviewed through analysis of Maintenance Data System (MDS) data, Casualty Reports (CASREPTs), and system overhaul records. Initial findings from these sources were correlated with Planned Maintenance System (PMS) requirements, system alterations, and system technical manuals to identify maintenance problems. Ship surveys were conducted and discussions were held with appropriate technical codes to validate identified problem areas, identify undocumented maintenance problems, and determine the status of current and planned actions affecting the Fuel Oil Service and Transfer System. All findings were evaluated, and appropriate conclusions were developed. Recommendations were then formulated to (1) implement existing and newly defined corrective actions, (2) minimize the occurrence of identified problems and their impact on the extended operating cycle, and (3) identify the maintenance required throughout the operating cycle.

The major conclusions and recommendations resulting from the Review of Experience for the Fuel Oil Service and Transfer System are summarized as follows:

- The system is capable of operating over an extended cycle with no major restorative maintenance being required.
- There are very few problems with this system at this time.
- The system can be maintained by Ship's Force during an extended cycle, with minimal assistance from an Intermediate Maintenance Activity (IMA) facility.
- Particulate matter in the fuel oil is a major cause of wear in the pumps and valves that comprise the Fuel Oil Service and Transfer System.
- Current maintenance procedures are adequate to maintain the Fuel Oil Service and Transfer System throughout an extended cycle.

A summary of the recommendations from this analysis is presented in Table S-1.

Table S-1. SUMMARY OF FUEL OIL SERVICE AND TRANSFER SYSTEM RECOMMENDATIONS		
Component	Problem	Recommendation
Reliability and Maintainability Improvements		
Fuel Oil Service Pump	Susceptibility to wear	Change pump model from C6UEC-187 to D6UEC-187 by installing a new rotor housing (developed by DeLaval)
	Downtime for repairs	Provide a modular repair kit as an on-board spare
Baseline Overhaul Requirements		
Pumps: Emergency Fuel Oil Transfer Fuel Oil Service Port Use Fuel Oil Service Fuel Oil Transfer Fuel Oil Control Valve Fuel Oil Service Tanks	Assurance of satisfactory material condition prior to entry into extended cycle	Perform Class B overhaul in accordance with applicable TRSS Perform Class B overhaul Clean and preserve; remove tank heating coils if not already removed
Integrated Logistic Support Requirements		
Fuel Oil Service Pump	Modify APL 016160736	Update APL to reflect an allowance for one on-board spare modular repair kit (NIIN 123-3681)

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

In support of the Destroyer Engineered Operating Cycle (DDEOC) Program, sponsored by NAVSEA 934X, System Maintenance Analyses (SMAs) are being conducted on selected systems and subsystems of program-designated surface combatants. This principal element of an SMA is the Review of Experience (ROE). This report documents the ROE for the FF-1052 Class Fuel Oil Service and Transfer System, which was selected for analysis because equipments of this system are on the FF-1052 Class Maintenance Critical Equipment List.

1.2 PURPOSE AND SCOPE

An ROE is an analysis of existing and anticipated problems that affect the operational performance or maintenance program of a ship system. The ROE report serves as a vehicle for assessment of the significance and consequences of identified problems. It also presents specific recommendations and a system maintenance policy directed toward preventing or reducing the impact of problem occurrence while improving material condition and maintaining or increasing system availability throughout an extended ship operating cycle.

The analysis documented herein is specifically applicable to the Fuel Oil Service and Transfer System of the FF-1052 Class after the ND fuel conversion. Only those system components that had been installed or were on board ship as of the fourth quarter of Fiscal Year 1976 were considered. The analysis used all available documented data sources from which system maintenance problems could be identified and studied. These included Maintenance Data System (MDS) data, Casualty Reports (CASREPTs), and system overhaul records, in addition to Planned Maintenance System (PMS) requirements data, system alteration documentation, and system technical manuals. Sources of undocumented data employed in this analysis included discussions with Ship's Force and other cognizant technical personnel.

1.3 SYSTEM FUNCTION AND BOUNDARIES

The purpose of this system is to move Navy Distillate (ND) or marine diesel fuel (NMD) from the storage tanks to the service tanks and then to the fuel oil burners. This is accomplished by a combination of three pumps in the fuel oil service system, two pumps in the fuel oil transfer system, several filters, and an extensive valve and piping complex. A more detailed description of the system and a more complete listing of system components is contained in Appendix A. This ROE does not address either the fuel oil storage tanks or the propulsion boilers.

1.4 REPORT FORMAT

The remaining chapters of this report describe the analysis approach utilized (Chapter Two), briefly define significant system maintenance problems encountered and discuss potential problem solutions (Chapter Three), and summarize all the conclusions and recommendations derived from the analysis (Chapter Four). Specific analyses and evaluations that support the results of the effort reported herein are included in appendixes to this report. A selected list of information sources precedes the appendixes.

CHAPTER TWO

APPROACH

2.1 OVERVIEW

This chapter describes the approach to the performance of the ROE for the Fuel Oil Service and Transfer System. Primary data sources are identified in Chapter One, Section 1.2. The data were used to identify, define, and analyze maintenance problems that will significantly affect the Fuel Oil Service and Transfer System's maintenance program. A recommended course of action relative to this maintenance program was formulated on the basis of the analysis results.

The major steps of the Fuel Oil Service and Transfer System ROE were as follows:

- Compiling relevant documented and undocumented maintenance history data
- Analyzing these data to identify and define maintenance problems expected to have significant impact on maintenance of the system
- Analyzing problems and formulation of alternative solutions as a basis for recommending a specific course of action for the system maintenance program

Each of these activities is described in subsequent paragraphs.

2.2 DATA COMPILATION

The analysis began with a determination of the dates on which each of the ships in the Class converted to Navy Distillate (ND) Fuel. These dates were used as the starting point for compiling a comprehensive data file on the maintenance history of the system. The data file developed consisted of four key elements -- an MDS data bank, a CASREPT narrative summary, a system overhaul experience summary, and a system ShipAlt summary. A library of appropriate technical manuals, bulletins, etc., was also compiled. All MDS data reported for the FF-1052 Class from the date of conversion to ND Fuel (see Appendix A) through 31 October 1976 were screened for information specifically relevant to the system. Overhaul experience was obtained from 3-M Mechanized Departure Reports for the FF-1052 Class. Continued reference was made to all of the noted sources throughout the analysis.

2.3 PROBLEM DEFINITION

Potential problems with the system and its components were identified by a screening process that involved the use of MDS data, CASREPT information, information obtained during ship surveys and discussions with Navy technical personnel, overhaul reports, and, when appropriate, data available on NAVSEA special-interest items.

The MDS data was the initial and primary base of information used in the screening process. This data base includes the number of maintenance actions reported against particular components, dates of occurrence of those actions, components' associated APL numbers, man-hours associated with the action, and special codes related to the nature of the action, i.e., when discovered, cause, and action taken. Information about the number of parts ordered, when ordered, cost per part, the ship for which a part was ordered, and part nonmenclature are also included. The screening process identified the components that were the major contributors to the maintenance burden of the main lube oil and propulsion transmission system.

Components that were screened according to the maintenance man-hours and part replacement dollars reported against their associated APL numbers during the data period were then ranked in order of their maintenance burden as reported in the MDS. CASREPT data were also summarized by component. A component was singled out for in-depth analysis if a significant number of maintenance actions or CASREPTs had been submitted against it. Additional components were subjected to in-depth analysis if other sources of information (e.g., ship surveys, overhaul experience, etc.) indicated significant concern over problems.

Several factors associated with problems were then identified. These factors included the effect of the problem on the component and system, the interval between occurrences of the problem, the redundancy of the affected component within the system, the criticality of the component to the system, the resources required to perform the maintenance necessary to correct the problem, and the expected component or system downtime.

2.4 ANALYSIS OF COMPONENT PROBLEMS AND DEFINITION OF SOLUTIONS

Once the component problems and the causes of the problems were identified, solutions were sought first by examining each problem in relation to the extent to which it is recognized and its susceptibility to established types of corrective action. These analysis criteria can be expressed in the following questions:

- Is the problem known to the Navy technical community and has a solution been proposed or established?
- Will a design change reduce or eliminate the problem?
- Is the problem PMS-related? Can the problem be reduced or eliminated by changes to PMS? (These changes might include adding or deleting requirements, changing requirement periodicity, or developing material condition assessment tests and procedures.)

- Can the problem be reduced or eliminated by improving the system's Integrated Logistics Support (ILS)?
- Can the problem be reduced or eliminated by improving Ship's Force, Intermediate Maintenance Activity (IMA), or depot-level capabilities?
- Can the problem be reduced or eliminated by periodically performing restorative maintenance? Should this be accomplished at a Selected Restricted Availability (SRA) by Ship's Force, IMA, or depot-level facilities?
- Is the run-to-failure concept a viable maintenance strategy for the associated component?

An affirmative answer to any question resulted in analysis of the effects of the solution and in an estimate, when possible, of the cost to implement the solution. A negative answer prompted the analyst to go to the next question. After all the questions concerning an individual problem were asked, the alternative near-term and long-term solutions were evaluated and the most acceptable alternatives defined and documented as recommendations. "Near-term" recommended solutions, as used in this report, are those that are likely to be and that should be accomplished prior to completion of the initial FF-1052 Class Baseline Overhauls. "Long-term" recommended solutions are those that are not likely to be accomplished until some or all of the FF-1052 Class Baseline Overhauls have been completed.

The historical overhaul experience for all installations of each selected component was then correlated with the recommended problem solutions. An evaluation was made to establish the Baseline Overhaul requirements for each selected component.

CHAPTER THREE

RESULTS

3.1 OVERVIEW

This chapter presents the results of the analysis of the Fuel Oil Service and Transfer System installed on the FF-1052 class ships. At the time of the analysis, each ship in the class had been converted to the use of Navy Distillate (ND) Fuel, which requires equipments different from the Navy Special Fuel Oil (NSFO) system. Accordingly, the date of conversion to ND fuel was the starting point for the analysis for each ship. The conversion dates are listed in Table A-2 of Appendix A.

The data analyzed -- based on maintenance experience through December 1976 -- represented a total of 143.8 ship operating years. In this aggregate period of operation, the Fuel Oil Service and Transfer System was not a major maintenance burden, nor were significant problems identified. On the average, the system experienced 68 man-hours of maintenance per ship operating year. Data screening resulted in the identification of 9 system components as the major contributors to the corrective maintenance burden. Their contributions are summarized in Table 3-1. Collectively, these nine components accounted for about 61 percent of the reported man-hour burden of the system. No other components experienced maintenance burdens of enough significance to warrant further analysis.

Three of the components listed in Table 3-1 have been eliminated as problems as the result of an analysis of MDS narratives, parts usage data, and CASREPTs. The reported maintenance on the Port Use Fuel Pump (APL 016160549) and the Fuel Oil Transfer Pumps (APLs 016160665 and 016160748) involved: replacement of consumable parts (i.e., packing and gaskets), scheduled PMS checks that were erroneously charged as corrective maintenance actions, or nonrecurring or one-of-a kind maintenance actions. These pumps are not discussed further in the report.

One part with a replacement cost exceeding \$1000 was replaced during the data period. This was the modular repair kit (NIIN 123-3681) for the Fuel Oil Service Pump (APL 01610736). This kit has been in the fleet for only a short time, and available data disclosed only two reports of its use.

Table 3-1. MDS DATA SUMMARY OF SELECTED FF-1052 CLASS FUEL OIL SERVICE AND TRANSFER SYSTEM APLs												
APL	Nomenclature	Applicable Ships	Equipments per Ship	Total Equipment Population	Ship Operating Time (Ship-Years)	Ships Reported	JCNs	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Parts Cost (Dollars)	Average Man-Hours/ Equipment/ Operating Year
016020855	Emergency Fuel Oil Transfer Pump	26	1	26	81.8	25	71	751	320	1,071	18,318	13.1
016031735	Emergency Fuel Oil Transfer Pump	20	1	20	62.0	14	79	401	172	573	5,124	9.2
016160549	Port Use Fuel Oil Pump	20	1	20	62.0	15	34	208	189	397	6,019	6.4
016160665	Fuel Oil Transfer Pump	20	1	20	62.0	11	26	86	114	200	7,620	3.2
016160736	Fuel Oil Service Pump	46	2	92	143.8	19	48	456	88	544	19,268	1.9
016160748	Fuel Oil Transfer Pump	26	1	26	81.8	10	21	306	449	755	8,529	9.2
6120101942)	Fuel Oil Control Valve	46	2	92	143.8	14	45	193	68	261	8,912	0.9
750260097	Duplex Strainer	19	2	38	58.0	17	53	259	302	561	1,347	4.8
750430221	Duplex Strainer	27	2	54	82.1	26	105	620	975	1,595	3,400	9.7
Totals							482	3,280	2,677	5,957	78,537	
Total Reported for All System APLs							829	5,360	4,416	9,776	89,463	68*
Percent of Total Accounted for by System APLs							58.1	61.2	60.6	60.9	87.8	
*Average system man-hour burden per ship per operating year.												

3.2 EMERGENCY FUEL OIL TRANSFER PUMPS, APLs 016020855 and 016031735

3.2.1 Background

One emergency fuel oil transfer pump is installed in each of the ships of the class (see Appendix A). Pumps manufactured by Warren Pumps, Inc., are installed in hulls FF-1052 through FF-1077. FF-1078 through FF-1097 are equipped with pumps manufactured by Worthington Marine and Industrial Products, Inc. They are steam-driven reciprocating pumps used primarily for pumping bilges and stripping the fuel oil tanks; however, they are also used as emergency backup for the fuel oil transfer pumps. Because of the reliability of the fuel oil transfer pumps, the emergency fuel oil transfer pumps are rarely used for emergency purposes.

3.2.2 Discussion

The maintenance burden for the emergency fuel oil transfer pumps has not been significant. However, these pumps have accounted for approximately 17 percent of the total man-hours and 26 percent of the total parts cost reported against the Fuel Oil Service and Transfer System. Analysis of the MDS-reported cause codes has shown that almost half of the maintenance actions reported against these pumps are due to normal wear. This finding is supported by CASREPT data, which indicate that 6 out of 7 CASREPTs are due to normal wear (see Appendix B). The other maintenance actions involved the performance of preventive maintenance (PMS) erroneously recorded as corrective maintenance and accounted for approximately 30 percent of the burden reported against the system. Reduction of the total man-hour burden by this factor results in an average man-hour expenditure of 9.2 man-hours per equipment per ship per operating year.

Although the emergency fuel oil transfer pumps have contributed more to the maintenance burden of the Fuel Oil Service and Transfer System than any other system component, the level of the maintenance burden is not considered excessive nor indicative of a problem equipment. Therefore, no recommendations for improvement have been made. Recommendations relative to BOH maintenance requirements are presented in Section 3.8.

3.2.3 Recommendations

The following near-term and long-term actions are recommended:

- Near Term - See BOH Requirements, Section 3.8.
- Long Term - At each subsequent ROH, the pumps should receive a Class B overhaul or Class C repairs indicated necessary by the Ship's CSMP or POT&I results.

3.3 FUEL OIL SERVICE PUMP, APL 016160736

3.3.1 Background

Two fuel oil service pumps (model C6UEC-187, manufactured by DeLaval Turbine Incorporated) are installed in each FF-1052 Class ship. Their function is to provide ND or MD fuel oil to the burners. Each pump is fully capable of providing sufficient fuel at the prescribed pressure to operate both boilers throughout their full firing range. The presence of two installed fuel oil service pumps on each ship of the class provides 100 percent redundancy for this service.

3.3.2 Discussion

Although the fuel oil service pump has contributed the largest parts dollar expenditure of any component in the Fuel Oil Service and Transfer System, its maintenance burden in terms of man-hours expended per equipment per ship operating year is only 1.9 man-hours. There have been 18 CASREPTs submitted on this pump over the period it has been installed in the Fleet. Analysis of MDS data cause codes indicates that 71 percent of the reported maintenance actions were attributed to normal pump wear. This finding tends to be supported by CASRET analyses (Appendix B), which show that 39 percent of the 18 reported CASREPTs are due to normal wear. Such wear is often described as including varying degrees of scoring of the pump rotors and rotor housing. If deep enough, this scoring can reduce the output pressure of the pump. To reduce excessive wear, DeLaval has developed a new rotor housing lined with a babbitt-like material that is more resistant to scoring than the cast metal. (Incorporation of this rotor housing changes the pump model number to D6EUC-187.) NAVSECPHILADIV's opinion is that this new housing should enhance the reliability of the system.

In most cases, the pump can be completely maintained and overhauled by Ship's Force, as confirmed during conversations with PACFLT Ship's Force and Tender personnel, Development and Training Center/Fleet Maintenance Assistance Group (DATC/FMAG), and SURFPAC. They each stated that all maintenance and overhauls had been performed by Ship's Force. However, SURFLANT personnel indicated that it was occasionally necessary to send outside assistance to the ships. As a result of contacts with Ship's Force, SURFLANT and SURFPAC personnel, it was concluded that required corrective maintenance during an extended cycle could be accomplished with no additional burden on IMA facilities.

In an effort to reduce the scoring of the rotor housing and to facilitate pump repair, a modular pump repair kit (NIIN 123-3681) was developed by DeLaval. The kit consists of a rotor housing, power and idle rotors, seals, "O" rings, thrust plate, and other internal parts. This kit can be installed as a unit, greatly reducing the time and effort formerly necessary to replace the individual parts within the pump. However, the current Allowance Parts List (APL) dated March 1, 1976, does not list this item.

3.3.3 Recommendations

The fuel oil service pumps have not been in service long enough to define an expected overhaul interval; however, the manufacturer and NAVSEC agreed that this pump should perform reliably throughout an extended operating cycle, especially if the new rotor housing is installed. The addition of a modular pump repair kit as an on-board spare should facilitate any intracycle overhaul requirements by Ship's Force and reduce the time required to perform such corrective maintenance. Near-term and long-term recommendations are as follows:

- Near Term
 - Convert the DeLaval pump, model C6UEC-197, to model D6UEC-187 during the next pump overhaul but no later than BOH. If this conversion has been completed, overhaul in accordance with TRS 0621-086-606, 0261-086-608, or 0261-086-609 (see BOH recommendations, Section 3.8).
 - Change APL 016160736 to reflect the addition of one pump repair kit (NIIN 123-3681) to the on-board spares allowance.
- Long Term - During subsequent ROHs, perform Class B overhaul or Class C repairs indicated necessary by POT&I results or Ship's CSMP.

3.4 FUEL OIL CONTROL VALVE, APL 612010194 (Z)

3.4.1 Background

The Fuel Oil Control Valve is an interface between the Automatic Combustion Control System (ACC) and the Fuel Oil Service System. Its function is to regulate burner fuel oil pressure in response to ACC pneumatic demand signals. In the event of failure, its function can be performed by a manually operated fuel-oil micrometer valve. These valves are critical to the proper operation of the Fuel Oil Service System.

3.4.2 Discussion

The Fuel Oil Control Valve is diaphragm-controlled and relies on ACC control air and fuel oil pressure for proper function. Input air pressure exerts a force on a cupped diaphragm to position the valve piston in the sleeve; the position of the piston regulates the amount of oil flowing through the sleeve ports. The piston and sleeve, which are closely fitted to prevent leakage, are susceptible to wear and scoring from any impurities in the oil that pass through the filters. Examination of MDS narratives and discussions with Ship's Force personnel indicate that most maintenance actions are the result of wear on the piston and can normally be corrected by Ship's Force.

3.4.3 Recommendations

- Near Term - See BOH recommendations, Section 3.8.
- Long Term - During follow-up ROH, accomplish overhaul or Class C repairs indicated necessary by POT&I or Ship's CSMP.

3.5 DUPLEX STRAINERS, APLs 750260097 AND 750430221

3.5.1 Background

The duplex strainers are located on the downstream side of the fuel oil service pumps; they act as a final filter for the fuel oil before it enters the fuel oil control valve and the supply manifold at the boilers. One duplex strainer is located in the fuel line to each boiler. APL 750260097 is installed in most of the earlier ships of the Class -- FF-1052 through FF-1077 (see Appendix A for exceptions) -- and APL 750430221 is installed in the remainder.

3.5.2 Discussion

The maintenance burden attributed to these strainers is caused primarily by two types of maintenance actions. The first consists of repairs required because of normal part wear and deterioration; the second involves the necessity for local manufacture of replacement strainer baskets and duplex strainer shields, the latter requiring the greatest expenditure of man-hours and parts dollars. Strainer baskets for APL 750260097 are not carried in the supply system and must be manufactured by an IMA facility from a sample provided by the ship. This process, according to Ship's Force, usually takes two to three days, during which time the equipment is inoperative. If two spare strainer baskets were fabricated whenever the old baskets were replaced and carried as on-board spares, this downtime could be avoided.

The second strainer (APL 750430221), installed primarily on the newer ships of the class, is supported by the Navy supply system and usually does not require IMA maintenance support. However, applicable MDS narratives indicate that many maintenance actions involved the manufacture and installation of shields for the strainers to meet system safety standards. This is a one-time maintenance action; it should not be repetitive.

The function of these strainers is to remove sediment from the fuel oil. Failure of the strainer to remove sediment would result in excessive wear of the system components downstream. To ensure proper operation of the strainer during an extended operating cycle, the strainer must be in the best possible material condition prior to entering such a cycle. This condition would be assured by giving these strainers a Class B overhaul during the BOH.

3.5.3 Recommendation

- Near Term - See BOH recommendations, Section 3.8.
- Long Term - During follow-up ROH, accomplish overhaul or Class C repairs indicated necessary by POT&I or Ship's CSMP.

3.6 VALVES

3.6.1 Discussion

There are approximately 200 different valves in use in the Fuel Oil Service and Transfer System. Not all of these valves are installed on each ship, but a specific valve may be used many times within the system on a single ship. The total number of valves in this system for all the ships in the class is about 5,000. Although no single valve made a significant contribution, these valves account for about 30 percent of all man-hours spent on maintaining the system. This is an average of approximately sixty man-hours per ship to maintain the valves in the system during the data period.

Since individual valves have a low average man-hour and parts usage rate, and since the Type Commanders have a structured valve maintenance program, these valves should not be a major burden during an extended operating cycle. Therefore, no recommendations are in order.

3.7 FUEL SYSTEM

3.7.1 Discussion

During the analysis of the Fuel Oil Service and Transfer System, many internal parts of pumps and valves were reported as showing signs of scoring. In most reported maintenance actions, this was attributed to normal wear; however, Ship's Force and NAVSEC personnel report that many of the fuel oil tanks contain large quantities of foreign material that, when introduced into the system, produce scoring and excessive wear.

SURFLANT reported that a NAVSEC investigation revealed that the sludge in the tank bottoms was not normally a major problem; however, when the ship began to move in a seaway, the sludge formed a slurry that entered into the fuel oil service system. The same investigation revealed that the fuel oil heating coils acted as a collection point for dirt. Following the conversion to ND fuel, the tank heating coils are removed from the ships as time and funds become available. However, since the tanks act as a collection point for dirt, they should be removed as soon as possible but no later than BOH. Although tanks were not specifically included in this ROE, it is obvious that their condition has an effect on the Fuel Oil Service and Transfer System. A thorough cleaning of these tanks would remove most of the foreign material and minimize damage and wear to system components.

3.7.2 Recommendations

The following near-term actions should be taken during BOH:

- Thoroughly clean the fuel oil tanks, giving particular attention to the service tanks.
- Remove the fuel oil heating coils from the fuel tanks if they have not already been removed.

3.8 BASELINE OVERHAUL REQUIREMENTS

The baseline Overhaul concept in the DDEOC Program is designed to ensure that ships entering an extended operating cycle are in a state of material condition readiness such that there is a high probability of operation without major restorative maintenance throughout the extended cycle. In keeping with this philosophy, it will be necessary to overhaul all major components of the Fuel Oil Service and Transfer System and thoroughly clean and preserve the fuel oil service tanks during BOH. To enhance reliability, all remaining fuel oil heater coils should be removed so that they cannot serve as a dirt-collecting surface in the future. Table 3-2 presents specific recommendations for Baseline Overhaul.

Table 3-2. BASELINE OVERHAUL REQUIREMENTS	
Component/Equipment	Recommendation
Emergency Fuel Oil Transfer Pump	Perform Class B Overhaul
Port Use Fuel Oil Pump	Overhaul in accordance with TRS 0621-086-602
Fuel Oil Transfer Pump	Overhaul in accordance with TRSs 0541-086-603 and 0541-086-604, as applicable
Fuel Oil Service Pumps	Overhaul in accordance with TRSs 0261-086-606, 0261-086-608, and 0261-086-609, as applicable
Fuel Oil Control Valve	Perform Class B Overhaul
Duplex Strainer Assembly	Perform Class B Overhaul
Fuel Oil Service Tanks	Thoroughly clean Service Tanks remove tank heating coils if not already removed*
Fuel Oil Quick Closing Valves	Perform Class B Overhaul
*Should be added to Baseline SARP for BOH, dated 1 March 1977.	

3.9 MAINTENANCE PHILOSOPHY

The analysis conducted for this ROE does not show the system to be a major maintenance burden. The existing preventive maintenance procedures are adequate and are easily accomplished by Ship's Force. There is no excessive expenditure of parts dollars or man-hours in support of this system, nor has excessive downtime been routinely experienced. Therefore, no major changes to the current maintenance practices and procedures are warranted.

Maintenance during the cycle should be limited to routine upkeep performed by Ship's Force. Class C repairs identified as necessary by the ship's CSMP should be accomplished by Ship's Force personnel supported by an IMA facility, as appropriate, during availability periods. Because the ND conversion has been on board the ships of the class for a short time (average of 3.1 years), a firm periodicity for system pump overhaul has not been established. Class B overhaul or Class C repairs to the pumps should be accomplished during ROH only as indicated as necessary by POT&I results and the ship's CSMP.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

Significant conclusions resulting from this ROE are as follows:

- Major restorative maintenance of the Fuel Oil Service and Transfer System will not be required during an extended operating cycle.
- Ship's Force is capable of maintaining the system with minimal assistance from IMA activities.
- A major source of wear in the system is the particulate contaminants in the fuel oil, the source of which has been identified as dirty fuel tanks.
- Current maintenance procedures are adequate to maintain the Fuel Oil Service and Transfer System throughout an extended operating cycle.

4.2 RECOMMENDATIONS

Corrective actions and planning activities identified by this ROE are categorized as follows:

- Reliability and Maintainability Improvements
- Baseline Overhaul (BOH) Requirements
- Integrated Logistic Support (ILS) Improvements

Specific recommendations of this ROE are summarized in Table 4-1. All recommended component problem solutions and BOH requirements are listed in Appendix C.

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Table 4-1. SUMMARY OF FUEL OIL SERVICE AND TRANSFER SYSTEM RECOMMENDATIONS		
Component	Problem	Recommendation
Reliability and Maintainability Improvements		
Fuel Oil Service Pump	Susceptibility to wear	Change pump model from C6UEC-187 to D6UEC-187 by installing a new rotor housing (developed by DeLaval)
	Downtime for repairs	Provide a modular repair kit as an on-board spare
Baseline Overhaul Requirements		
Pumps: Emergency Fuel Oil Transfer Fuel Oil Service Port Use Fuel Oil Service Fuel Oil Transfer Fuel Oil Control Valve Fuel Oil Service Tanks	Assurance of satisfactory material condition prior to entry into extended cycle	Perform Class B overhaul in accordance with applicable TRSs Perform Class B overhaul Clean and preserve; remove tank heating coils if not already removed
Integrated Logistic Support Requirements		
Fuel Oil Service Pump	Modify APL 016160736	Update APL to reflect an allowance for one on-board spare modular repair kit (NIIN 123-3681)

SOURCES OF INFORMATION

The principal sources of information used as the basis for the System Maintenance Analysis of the Fuel Oil Service and Transfer System are listed below.

1. Generation IV MDS Part and Maintenance Data for DE/FF-1052 Class, from ND conversion through 30 October 1976.
2. Type Commander's COSAL, SURFLANT (dated 28 April 1976) and SURFPAC (dated 23 June 1976).
3. CASREPT Narrative Summaries from conversion through 30 June 1976.
4. *Propulsion Plant Manual for Frigates*, NAVSEA 0941-LP-053-3010 (1 January 1976).
5. *1200 PSI Propulsion Plant Test and Certification Manual*, Appendix A-9, FF-1052 Class, NAVSEA 0941-LP-053-6010.
6. *Equipment Manual, Turbine-Driven Fuel Oil Service Pump*, NAVSHIPS 0947-188-1010 (15 October 1972).
7. *Equipment Manual for Bilge and Tank Stripping Pump*, NAVSHIPS 0947-057-3010 (September 1966).
8. *Equipment Manual for Motor-Driven Port Fuel Oil Service Pump*, NAVSHIPS 0947-090-2010.
9. *Equipment Manual, Motor-Driven Fuel Oil Service Pump*, NAVSHIPS 0947-186-7010 (July 1973).
10. *Equipment Manual for Fuel Oil Micrometer Valve*, NAVSHIPS 0948-046-5010.
11. APLs (various) dated 3/01/76.
12. *Ship Alteration Information Manual for FF-1052 Class*.
13. *Naval Ships Technical Manual, Chapter 9470 Pumps*, NAVSHIPS 0901-470-0002.
14. *Naval Ships' Technical Manual, Chapter 9550, Petroleum Fuel Stowage, Use and Testing*, NAVSHIPS 0901-550-0003.

APPENDIX A

FUEL OIL SERVICE AND TRANSFER SYSTEM BOUNDARIES

This appendix presents the boundaries used in the analyses of the Fuel Oil Service and Transfer System. Figure A-1 is a schematic of the Fuel Oil Service System and Figure A-2 shows the locations of the components of the Fuel Oil Transfer System. Table A-1 lists the principal components, not including the valves, of the system and is based on information contained in the Type Commander's COSAL. Table A-2 is a listing of the Navy Distillate conversion dates that were used in this analysis to eliminate data reported on the obsolete NSFO equipments.

LEGEND	
	STOP VALVE
	AMBLE STOP VALVE
	RELIEF VALVE
	SPRING CHECK VALVE
	LIFT CHECK VALVE
	STOP CHECK VALVE
	BUTTERFLY VALVE
	3 WAY, 3 PORT VALVE
	2 POSITION PLUS VALVE
	VALVE WITH PRESSURE INDICATOR
	MOTOR DRIVEN
	LOCKED CLOSED
	LOCAL AND/OR REMOTE
	SUPPLY METERS
	UNLOADING VALVE
	QUICK CLOSING VALVE
	DUPLEX STRAINERS

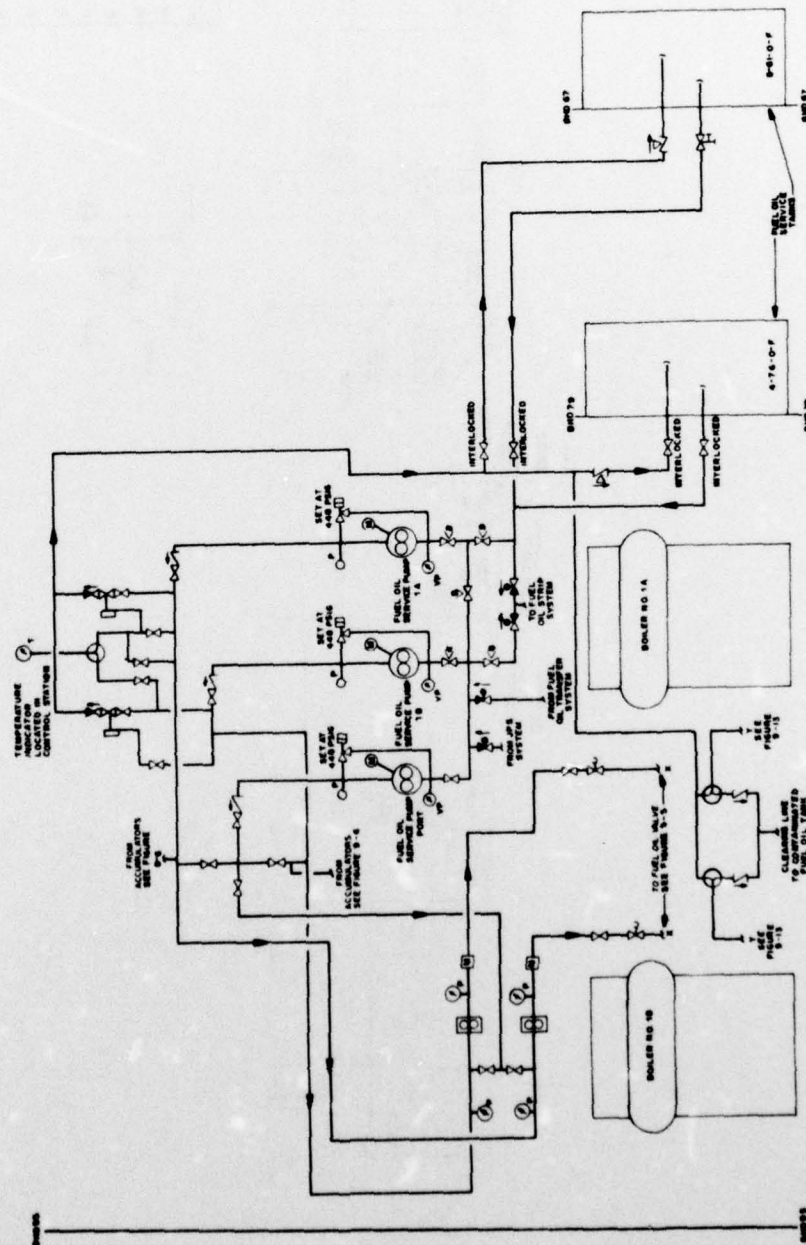


Figure A-1. FUNCTIONAL DIAGRAM OF THE FUEL OIL SERVICE SYSTEM

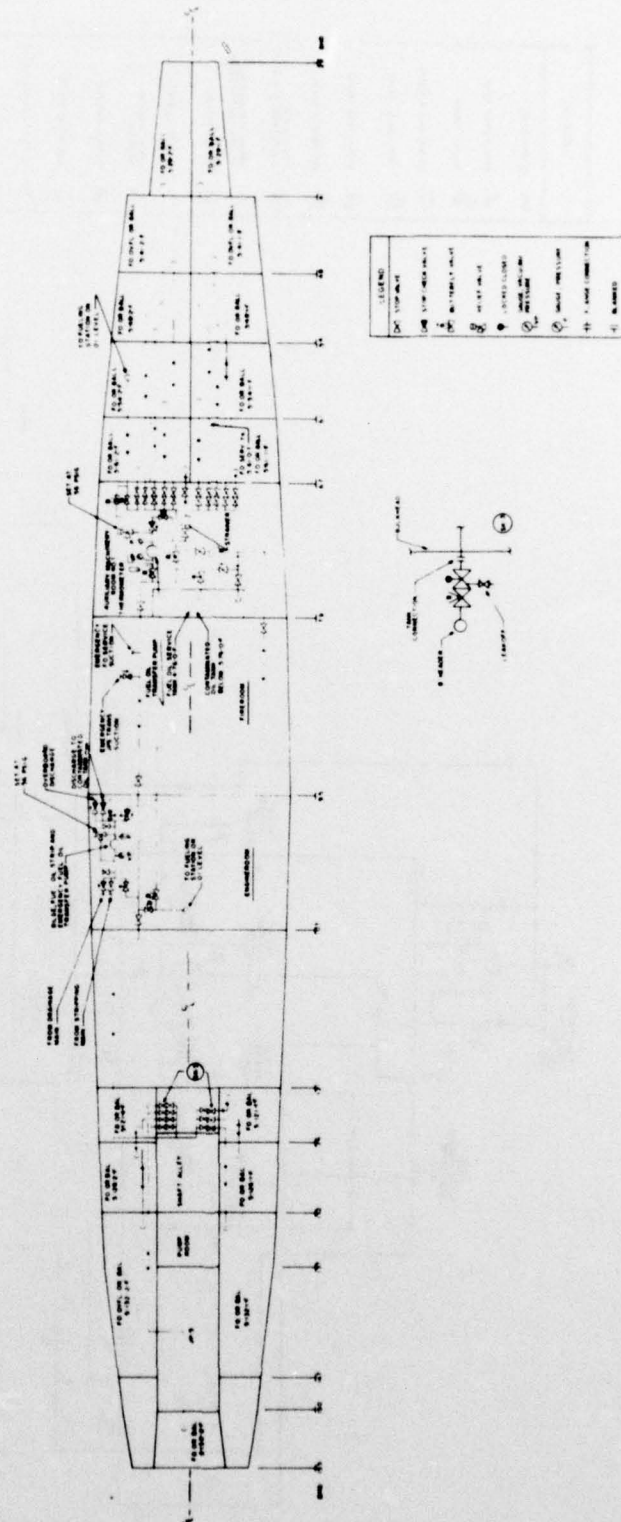


Figure A-2. TYPICAL LOCATION OF FUEL OIL TRANSFER SYSTEM COMPONENTS ON FF-1052 CLASS SHIPS

Table A-1. PRINCIPAL COMPONENTS OF THE FUEL OIL SER

Nomenclature	SWBS	EIC	APL/CID	FF-1052	FF-1053	FF-1054	FF-1055	FF-1056	FF-1057	FF-1058	FF-1059	FF-1060	FF-1061	FF-1062	FF-1063	FF-1064	FF-1065	FF-1066	FF-1067	FF-1068	FF-1069	FF-1070	FF-1071
Pump, Rcipg VSDA 6x7x12			016020855	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
100 GPM, 50 PSI																							
Pump, Rcipg VSDA 6x7x12			016031735																				
100 GPM, 50 PSI																							
Pump, Rty Pwr 140 GPM			016160549																				
400 PSI, 3500 RPM, MD																							
Pump, Rty, Pwr 265 GPM			016160665																				
38 PSI, 1800 RPM, MD																							
Pump, Rty Pwr 37 GPM 350 PSI MD			016160736	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Pump, Rty Pwr 15 GPM 350 PSI			016160746	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3500 RPM MD																							
Pump, Rty Pwr 240 GPM 60 PSI			016160748	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1800 RPM MD																							
Controller, AC Mag LVP SZ 2			151207592																				
400 V 2 SPD 1 WDG DRPR																							
Controller, AC Mag LVP SZ 3			151207834																				
440 V, 2 SPD 1 WDG DRPR																							
Controller, AC MAG LVP SZ 2 440 V 2 SPD 1 WDG			151207836																				
Controller, AC Mag LVP SZ 1			151209044																	1			
440 V 2 SPD																							
Controller, AC Mag LVP SZ 2			151209207	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1
440 V 2 SPD 1 WDG DRPR																							
Controller, AC MAG LVP SZ 3			151209281	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
440 V 2 SPD, 1 WDG DRPR																							
Controller, AC MAG LVP SZ 2			151209282	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
440 V 2 SPD 1 WDG DRPR																							
Motor, AC 440 V, 40/20 HP			174342274	2		2	2		2	2	2	2	2	2	2	2	2	2	2	2	2		2
3600/1800 RPM																							
Motor, AC 2 SPD 440 V 20/10			174752246																				
HP																							
Motor, AC 2 SPD 440 V 40/20			174752295																				
HP																							

COMPONENTS OF THE FUEL OIL SERVICE AND TRANSFER SYSTEM

		Hull Numbers																																			
FF-1063		FF-1064	FF-1065	FF-1066	FF-1067	FF-1068	FF-1069	FF-1070	FF-1071	FF-1072	FF-1073	FF-1074	FF-1075	FF-1076	FF-1077	FF-1078	FF-1079	FF-1080	FF-1081	FF-1082	FF-1083	FF-1084	FF-1085	FF-1086	FF-1087	FF-1088	FF-1089	FF-1090	FF-1091	FF-1092	FF-1093	FF-1094	FF-1095	FF-1096	FF-1097		
1		1	1	1	1	1	1	1	1	1	1	1	1	1	1																						
																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																						
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																						
																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
																2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
					1					1																											
1	1	1	1	1	1		1	1	1		1	1	1	1	1																						
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2																						
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																						
2	2	2	2	2	2	2	2		2					2	2																						
																1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
																2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	

(continued)

2

Table A-1. (continued)

Nomenclature	SWBS	EIC	APL/CID	FF-1052	FF-1053	FF-1054	FF-1055	FF-1056	FF-1057	FF-1058	FF-1059	FF-1060	FF-1061	FF-1062	FF-1063	FF-1064	FF-1065	FF-1066	FF-1067	FF-1068	FF-1069	FF-1070	FF-1071
Motor, AC 2 SPD 440 V 10/5 HP			174752361																				
Motor, AC 2 SPD 440 V 10/5 HP			174752769	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Motor, AC 2 SPD 440 V 20/10 HP			174753080	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Motor, AC 2 SPD 440 V 20/10 HP			174753203	2			2															2	
Control VL FO 2 IN 300 PSI			612010194 (Z)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Strainer, DPLX 3.0 IN. STL			750260097	2	2	2	2		2	2		2		2	2	2	2	2			2	2	2
FLGE MESH																							
Strainer, SGL 4.0 IN. STL			750430204																			2	2
FLGE MESH																							
Strainer, DPLX 3.0 IN. STL			750430221				2			2		2						2	2				
FLGE MESH																							
Strainer, SGL 4.0 IN. STL			750430294											1							2		
FLGE PERF																							
Strainer, SGL 4.0 IPS STL			750430313																				
FLGE MAG																							
Strainer, SGL 3.5 IN. STL			754960041							2													
FLGE PERF																							
Strainer, SGL 4.0 IN. STL			754960060	2												2							
FLGE																							
Strainer, SGL 4.0 IN. BRZ			754960097											2									
FLGE PERF																							
Strainer, SGL 4.0 IN. STL			754960231																				
FLGE MESH																							
Accumulator HYD BAG TY CAP*			926000004		4		4			4		4											4
3000 PSI 10.0 GAL																							
Accumulator HYD BAG TY CAP*			926000056			4		4	4				4				4		4	4	4		
3000 PSI 10.0 GAL																							

*Sources indicate that all ships in the class have accumulators; however, the exact APL for each individual

Table A-1. (continued)

[illegible]

*Sources indicate that all ships in the class have accumulators; however, the exact APL for each individual hull

le A-1. (continued)

Hull Numbers	
FF-1064	
FF-1065	
FF-1066	
FF-1067	
FF-1068	
FF-1069	
FF-1070	
FF-1071	
FF-1072	
FF-1073	4
FF-1074	
FF-1075	
FF-1076	
FF-1077	
FF-1078	
FF-1079	
FF-1080	
FF-1081	
FF-1082	
FF-1083	
FF-1084	
FF-1085	
FF-1086	
FF-1087	4
FF-1088	
FF-1089	
FF-1090	
FF-1091	
FF-1092	
FF-1093	
FF-1094	
FF-1095	
FF-1096	
FF-1097	

PL for each individual hull is unknown.

2

Table A-2. NAVY DISTILLATE
CONVERSION DATES

Hull	ND Light-Off Date	Hull	ND Light-Off Date
1052	11-13-72*	1075	5-23-73
1053	9-30-74	1076	8-1-72
1054	11-14-75*	1077	11-20-72
1055	8-31-73	1078	7-5-73
1056	11-15-73	1079	11-5-73
1057	3-27-74	1080	8-13-73
1058	6-16-72	1081	10-29-71
1059	2-24-73	1082	10-2-72
1060	6-12-72	1083	9-25-72
1061	7-5-73	1084	2-2-73
1062	1-30-73	1085	6-6-73
1063	8-8-72	1086	2-2-73
1064	1-29-73	1087	6-5-73
1065	9-28-72	1088	10-15-73
1066	5-18-73	1089	1-3-74
1067	11-8-72	1090	2-13-74
1068	8-4-72	1091	3-18-74
1069	2-8-73	1092	5-28-74
1070	7-25-73	1093	10-12-74
1071	4-9-73	1094	10-18-74
1072	12-4-73	1095	1-26-74
1073	5-8-73	1096	3-24-74
1074	8-10-73	1097	5-20-74

*Sea trials following ND conversion.

APPENDIX B

CASREPT SUMMARY

CASREPTs for the FF-1052 Class, covering the period from conversion to Navy Distillate fuel through 30 June 1976, were categorized by components of the Fuel Oil Service and Transfer System. Table B-1 shows the individual contribution of each system component on which a CASREPT was submitted. It also shows the reason given for the CASREPT.

Figure B-1. CASREPT SUMMARY FOR THE FF-1052 CLASS FUEL OIL SERVICE AND TRANSFER SYSTEM												
Category	Percent of Total	Emergency Fuel Oil Transfer Pump		Port Use Fuel Oil Pump	Fuel Oil Transfer Pump	Fuel Oil Service Pump	Fuel Oil Transfer Pump	Fuel Oil Control Valve	Duplex Strainers		All Other	Total by Category
		016020855	016031735						016160665	016160736		
Wear	32	4	2	1		7			1		1	16
Unknown	16					4	2	2				8
Part Failure	14		1		1	1		1		1	2	7
Leaks	6								1	1	1	3
Low Pressure	6			1		2						3
Bearings	4					1	1					2
Cannibalization	6									2	1	3
Personnel Error	8					2				1	1	4
Foreign Object Damage	4					1					1	2
Miscellaneous	4				1						1	2
Total		4	3	2	2	18	3	3	2	5	8	50

APPENDIX C

DDEOC ACTION TABLE

DDEOC action items are presented in the table of this appendix. The table is formatted to provide the implementation status of changes through completion of the Class Maintenance Plan and to serve as a ready reference to specific paragraphs in Chapter Three that address in detail the problems involved.

DDEOC ACTION TABLE

ACTION ITEM *		DDEOC EVALUATION **	ACTION ITEM DESCRIPTION	REPORT REFERENCE (PARA.)	RESPONSIBILITY †
NO.	TITLE				
1.	Emergency Fuel Oil Transfer Pumps		1. Class B overhaul the pump during BOH; at each subsequent ROH the pumps should receive Class B or Class C repairs indicated as necessary by POT&I results and Ship's CSMP.	3.2	NAVSEA
2.	Fuel Oil Service Pump		1. Install DeLaval pump (Model D6UEC-187) during the next pump overhaul but no later than BOH. 2. Change APL 016160736 to reflect the addition of one pump repair kit (NIIN 1233681) to on-board spares allowance. 3. During subsequent ROHs, perform Class B overhaul or Class C repairs indicated as necessary by POT&I results and Ship's CSMP.	3.3 3.3 3.3	NAVSEC NAVSEC NAVSEA
3.	Fuel Oil Control Valve		1. Class B overhaul during BOH.	3.8	NAVSEA
4.	Duplex Strainers		1. Class B overhaul during BOH.	3.8	
5.	Fuel Oil Service Tanks		1. Thoroughly clean and preserve the fuel oil tanks, giving particular attention to the service tanks. 2. Remove the fuel oil heating coils from the fuel tank.	3.7 3.7	NAVSEA NAVSEA
6.	Fuel Oil Transfer Pump, Port Use Service Pump		1. Class B overhaul during BOH; during ROH, perform Class B overhaul or Class C repairs indicated necessary by POT&I.	3.8	NAVSEA
7.	Fuel Oil Quick Closing Valves		1. Class B overhaul during BOH.	3.8	NAVSEA

- * NOTE 1: DEVELOPING ACTIVITY FILL IN THE FOLLOWING BLOCKS: 1a, b; 3; 4; 5 (IF KNOWN); 6a, IF REQUIRED FOR CONTINUATION OF DEVELOPING ACTIVITY.
- * NOTE 2: DDEOC EVALUATION - APPROVED, FURTHER STUDY REQ'D, ETC.
- † NOTE 3: RESPONSIBILITY - ACTIVITY RESPONSIBLE FOR TAKING THE ACTION.

SHIP CLASS: FF-1052SMA NO: 112-260SYSTEM: F.O. Service and Transfer
System**DDEOC ACTION TABLE**

	4 REPORT REFERENCE (PARA.)	5 RESPONSIBILITY	6 SCHEDULING DATES			7 REMARKS, FUNDING IMPLICATIONS, ETC.	8 ACTUAL ACTION TAKEN
			a REQD.	b START	c COMP.		
g BOH; os s C by	3.2	NAVSEA					
REC- haul	3.3	NAVSEC					
the (NIIN lowance.	3.3	NAVSEC					
n Class indi- sults	3.3	NAVSEA					
	3.8	NAVSEA					
	3.8						
the lar	3.7	NAVSEA					
ils	3.7	NAVSEA					
uring or	3.8	NAVSEA					
	3.8	NAVSEA					

REQUIRED FOR CONTINUATION OF DEVELOPING ACTIVITY TASK; 7, AS NECESSARY.